

TABLE 3

Table 3: method of specifying the number of layers allocated and DMRS ports			
codeword 0 available, codeword 1 unavailable		both codewords available	
Value	Information	Value	Information
0	1 layer, port 7, $n_{SCID} = 0, N_{DMRS} = 1$	0	2 layers, port 8, $n_{SCID} = 0, N_{DMRS} = 1$
1	1 layer, port 7, $n_{SCID} = 1, N_{DMRS} = 1$	1	2 layers, ports 7-8, $n_{SCID} = 1, N_{DMRS} = 1$
2	1 layer, port 8, $n_{SCID} = 0, N_{DMRS} = 1$	2	2 layers, ports 7-8, $n_{SCID} = 0, N_{DMRS} = 2$
3	1 layer, port 8, $n_{SCID} = 1, N_{DMRS} = 1$	3	2 layers, ports 7-8, $n_{SCID} = 1, N_{DMRS} = 2$
4	1 layer, port 7, $n_{SCID} = 0, N_{DMRS} = 2$	4	2 layers, ports 9 and 10, $n_{SCID} = 0, N_{DMRS} = 2$
5	1 layer, port 7, $n_{SCID} = 1, N_{DMRS} = 2$	5	2 layers, ports 9 and 10, $n_{SCID} = 1, N_{DMRS} = 2$
6	1 layer, port 8, $n_{SCID} = 0, N_{DMRS} = 2$	6	3 layers, ports 7-9
7	1 layer, port 8, $n_{SCID} = 1, N_{DMRS} = 2$	7	4 layers, ports 7-10
8	1 layer, port 9, $n_{SCID} = 0, N_{DMRS} = 2$	8	5 layers, ports 7-11
9	1 layer, port 9, $n_{SCID} = 1, N_{DMRS} = 2$	9	6 layers, ports 7-12
10	1 layer, port 10, $n_{SCID} = 0, N_{DMRS} = 2$	10	7 layers, ports 7-13
11	1 layer, port 10, $n_{SCID} = 1, N_{DMRS} = 2$	11	8 layers, ports 7-14
12	2 layers, ports 7-8, $n_{SCID} = 0, N_{DMRS} = 1$	12	reserved
13	2 layers, ports 7-8, $n_{SCID} = 0, N_{DMRS} = 2$	13	reserved
14	3 layers, ports 7-9	14	reserved
15	4 layers, ports 7-10	15	reserved

[0128] According to another method, the number of REs for DMRS is not increased, i.e., the 12 REs filled with grids as shown in FIG. 14 are still used, the length of a Walsh code for time-expanded is increased to support MU-MIMO transmission of DMRS so as to multiplex more orthogonal DMRS.

[0129] A time-expanded code having a length of 4 is used on the 12 DMRS REs for MU-MIMO, and 4 DMRS ports that can be used are 7, 8, 11 and 13. Table 4 is the time-expanded codes to which the 4 ports are mapped. The relationships regarding orthogonality between the 4 time-expanded codes are different. For example, the time-expanded code of port 7 has the best orthogonality with the time-expanded code of port 8, but has the worst orthogonality with the time-expanded code of port 11. In conventional LTE standards, when dual-layer transmission is supported, port 7 and port 8 are allocated to a UE, i.e., allocating two time-expanded codes that have the best orthogonality of the 4 time-expanded codes as shown in Table 4 to the same UE. In order to add flexibility to DMRS allocation of a base station, during DMRS allocation, the two ports that have the best orthogonality in the 4 DMRS ports may be allocated to different layers of the same UE to reduce interference between the two layers of the UE, or may be allocated to different UEs to reduce interference between the UEs.

TABLE 4

Table 4: time-expanded codes of DMRS ports	
DMRS ports	time-expanded code
7	[+1 +1 +1 +1]
8	[+1 -1 +1 -1]
11	[+1 +1 -1 -1]
13	[+1 -1 -1 +1]

[0130] Table 5 illustrates a method for specifying the number of layers allocated and DMRS ports in accordance with an example of the present disclosure. When a single codeword is transmitted or re-transmitted using a single layer, indication information is required to specify one of DMRS ports 7, 8, 11, 13 and specify whether  $n_{SCID}$  is 0 or 1, thus there are 8 possibilities that need to be specified. When a single codeword is re- $n_{SCID}$ -transmitted and the number of layers in initial transmission is larger than or equal to 2, additional indication information is required to specify whether the number of layers is 2, 3, or 4, i.e., there are 3 possibilities, and  $n_{SCID}$  is 0 by default.

[0131] Regarding transmission of two codewords, when two layers are allocated to the UE, ports 7 and 8, or ports 11 and 13, or ports 7 and 11, or ports 8 and 13 may be used, and  $n_{SCID}$  may be 0 or 1, thus, there are 8 possibilities that need to be specified; when more than 3 layers are allocated to the UE, only SU-MIMO is supported, thus there are 6 possibilities, i.e., the total number of layers may be 3, 4, 5, 6, 7, 8, and  $n_{SCID}$  equals 0 by default.

TABLE 5

Table 5: method of specifying the number of allocated layers and DMRS ports			
codeword 0 available, codeword 1 unavailable		both codewords available	
Value	Information	Value	Information
0	1 layer, port 7, $n_{SCID} = 0$	0	2 layers, ports 7-8, $n_{SCID} = 0$
1	1 layer, port 7, $n_{SCID} = 1$	1	2 layers, ports 7-8, $n_{SCID} = 1$
2	1 layer, port 8, $n_{SCID} = 0$	2	2 layers, ports 11 and 13, $n_{SCID} = 0$
3	1 layer, port 8, $n_{SCID} = 1$	3	2 layers, ports 11 and 13, $n_{SCID} = 1$
4	1 layer, port 11, $n_{SCID} = 0$	4	2 layers, ports 7 and 11, $n_{SCID} = 0$
5	1 layer, port 11, $n_{SCID} = 1$	5	2 layers, ports 7 and 11, $n_{SCID} = 1$
6	1 layer, port 13, $n_{SCID} = 0$	6	2 layers, ports 8 and 13, $n_{SCID} = 0$
7	1 layer, port 13, $n_{SCID} = 1$	7	2 layers, ports 8 and 13, $n_{SCID} = 1$
8	2 layers, ports 7-8	8	3 layers, ports 7-9
9	3 layers, ports 7-9	9	4 layers, ports 7-10
10	4 layers, ports 7-10	10	5 layers, ports 7-11
11	reserved	11	6 layers, ports 7-12
12	reserved	12	7 layers, ports 7-13
13	reserved	13	8 layers, ports 7-14
14	reserved	14	reserved
15	reserved	15	reserved

[0132] According to the method of Table 5, the UE may perform channel estimation without the need of any information on the length of the time-expanded code, or the UE may perform channel estimation always regarding the length of the time-expanded code is 4.